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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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TROP PRUNER & HU, PC 8554 KATY FREEWAY SUITE 100 HOUSTON, TX 77024			WALKE, AMANDA C	
			ART UNIT	PAPER NUMBER
			1752	

DATE MAILED: 03/21/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

19

Office Action Summary

Application No.

10/688,521

Applicant(s)

MEAGLEY ET AL.

Examiner

Amanda C Walke

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 17 October 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-27 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-27 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 17 October 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

2. Claims 14, 7-19, and 22-27 are rejected under 35 U.S.C. 102(e) as being anticipated by Hallock et al (6,582,891 or 6,709,807).

Hallock et al disclose a process for reducing roughness from a surface of a patterned photoresist. The process includes exposing a substrate having the patterned photoresist thereon to a vapor, wherein the vapor penetrates into and/or reacts with the surface of the photoresist. The substrate having the patterned photoresist thereon is then heated to a temperature and for a time sufficient to cause the surface of the photoresist to flow and/or react with the vapor wherein the surface roughness decreases. Optionally, the substrate is exposed to radiation during the process to increase the etch resistance of the photoresist and/or facilitate the reaction of the vapor with the surface of the photoresist. There exists a need for a process for reducing the degree of edge roughness in patterned resist features without significantly affecting the critical dimensions of the feature. It is desirable that the process be extendable to those photoresists used to pattern features less than 250 nm, i.e., photoresists optimized and sensitive for exposure to activating radiation at wavelengths of 248 nm, 193 nm, 157 nm and the like. Moreover, it is desirable that the process be amenable to reducing edge roughness in positive tone photoresists as well as

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negative tone photoresists. Importantly, the process should be economical, easily implemented and not dependent upon the source or causal factors of the edge roughness. Optionally, the process further includes exposing the photoresist to activating radiation for a time and energy sufficient to increase an etching resistance of the photoresist prior to, simultaneous with or subsequent to exposing the photoresist to the vapor. The radiation that is used to expose the photoresist has a wavelength in the ultraviolet range, x-ray range or includes electrons generated from an electron beam, or the like. The vapor can be selected from a material that is reactive or nonreactive during the process. Preferably, the vapor is generated from a material with a boiling point less than about 200 degrees C at standard atmospheric conditions. Examples of suitable non-reactive vapors include ketones and esters such as acetone, methyl ethyl ketone, butyl acetate, ethyl lactate and propylene glycol methyl ether acetate. In another embodiment, the process for reducing edge roughness includes exposing a substrate having a patterned photoresist thereon to a reactive vapor. The reactive vapor diffuses into the surface of the photoresist and lowers the glass transition temperature at the surface exposed to the vapor. The substrate is heated to a temperature and for a time sufficient to cause the surface of the photoresist to flow wherein the surface roughness decreases. During the process, the patterned photoresist is exposed to an activating radiation prior to, simultaneous with or subsequent to exposing the substrate to the vapor wherein the activating energy reacts with the photoresist to generate a compound. The vapor reacts with the compound and adds mass to the photoresist. The compound is reactive with the vapor and is preferably, a free radical, a photoacid generator, a photobase generator, or the like. The vapor may be reactive or nonreactive with the photoresist depending on the choice of material selected to generate the vapor. In the case of a non-reactive

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vapor, the vapor penetrates into the surface of the photoresist and is believed to lower the glass transition temperature (T_g) at the surface of the photoresist such that the surface T_g is lower than a glass transition temperature for a bulk of the photoresist. That is, the surface T_g is lower than the T_g for the photoresist that was not exposed to any vapor. Subsequent heating of the photoresist at a temperature at or above the surface T_g causes the surface of the photoresist to flow and smooth out the surface irregularities. The flow of the photoresist can be controlled on a microscopic scale based on the parameters and materials selected for the process. That is, the depth of penetration of the solvent in the surface of the photoresist can be controlled and limited to the depth of the surface of irregularities such that subsequent flow of the exposed areas renders the surface smooth. It is preferred that the temperatures selected for selectively flowing the photoresist surface are below the T_g of the bulk photoresist or are for a time such that flow of the bulk photoresist is minimal and does not deleteriously affect the targeted critical dimension of the photoresist feature. The temperature used for heating the photoresist surface may be constant or variable. Typically, the temperatures used for flowing the photoresist surface are from about 20 degrees C to about 250 degrees C. The total time and temperature used is dependent on the photoresist thermal properties and the determination thereof is well within the skill of those in the art to optimize. The particular components of the non-reactive vapor are selected by their ability to form a vapor at vapor forming conditions and their ability to penetrate into the surface of the photoresist. Accordingly, the vapor can be a single material or a mixture generated from a solid, liquid or gas. Preferably, the vapor is a solvent or co-solvent for the polymer used in the photoresist. However, in some cases, it is desirable and advantageous to employ a material with which at least one of the components in the photoresist is only marginally

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soluble or miscible. It has been found that this will help control the extent of vapor penetration and subsequent plasticization. The solid, liquid and/or gas materials are exposed to a temperature and/or pressure sufficient to maintain the selected material in its vapor phase. The range of vapor pressures suitable for use in the present invention is in a range from about 1 atm to about 760 atm. In practice, preferred materials are liquids with a boiling point less than 200.degree. C. at standard atmospheric pressure. Examples of suitable solvents for forming the vapor include, but are not limited to, ketones such as acetone, methyl ethyl ketone, and esters such as butyl acetate, ethyl lactate and propylene glycol methyl ether acetate. Other materials suitable for use in the present invention will be apparent to one skilled in the art in view of this disclosure. Exposure to the vapor may be limited by time and/or by concentration (vapor pressure). The effect of such permeation and penetration into the surface of the photoresist will be to selectively lower the T_g at the surface via a plasticization of the polymer chains. Solvent plasticization is a well-known phenomena known to those skilled in the art to lower the T_g of polymers. This in turn will allow the polymer chains to flow in the vapor-permeated region at a lower temperature than that of the bulk resist.

Given the teachings of the reference, the instant claims are anticipated.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

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4. Claims 1-3, 5-14, and 16-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Saito (6,589,718) in view of Allen et al (5,665,527) and DeSimone et al (6,383,289).

Saito discloses a method of making a resist pattern is provided, which decreases or eliminates the fluctuation of deformation of original openings of a resist layer which is induced by the change of their density (i.e., the count of the original openings within a unit area) or by their location in the reflowing process. The method comprises the steps of (a) forming a resist layer on a target layer; (b) patterning the resist layer to form original openings and at least one slit in the resist layer; the slit surrounding the original openings and having a specific width; and (c) reflowing the resist layer patterned in the step (b) under heat to cause deformation in the original openings and the at least one slit, thereby contracting the original openings and eliminating the at least one slit; the original openings thus contracted serving as resultant openings for forming desired contact/via holes in the target layer; the resist layer having the resultant openings constituting a resist pattern. With an example of the prior-art methods to make smaller openings of the resist pattern, after original openings are formed in a resist layer, the resist layer is subjected to a heat treatment at a temperature higher than its softening point, thereby gradually causing plastic deformation in the resist layer. In this method, the dimensions of the original openings are decreased due to the plastic deformation while the shape of the original openings is well controlled. Prior to the start of the method according to the first embodiment, a substrate 1 is provided, which is mainly made of semiconductor. On the substrate 1, desired memory cells or logic cells (not shown) have been formed through a known process sequence. A dielectric target layer 11 is formed at the top of the substrate 1. Desired contact holes and/or via holes are formed in the target layer 11 by using the resist pattern (i.e., mask) to

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be made through the method according to the first embodiment explained below. In the method according to the first embodiment, first, a resist material is coated on the surface of the substrate 1 (i.e., on the target layer 11 of the substrate 1). Thus, a resist layer 2 is formed on the surface of the substrate 1. It is preferred that the resist layer 2 is made of a positive non-chemically-amplified photoresist containing a quinone-azide-system photosensitive material (e.g., known naphthoquinone azide), an alkali-soluble resin, and a solvent. As the alkali-soluble resin, novolac resin, polyhydroxystyrene or its derivative, styrene-maleic anhydride copolymer, or the like may be used. The resist layer 2 may be made of any positive chemically-amplified photoresist, which contains, for example, a polyhydroxystyrene resin protected by a tertiary butoxycarbonyl group and a light generator agent. Any other photoresist may be used for the resist layer 2. Any other resist than these photoresists may be used for the resist layer 2 if it gives some deformation through its reflowing process. Second, the resist layer 2 is selectively exposed to specific exposing light using a specific mask and then, it is developed with a developer solution to remove selectively the layer 2. Thus, circular original openings 3 and an L-shaped slit 4 are formed in the layer 2, as shown in FIGS. 2 and 3. The openings 3 are regularly arranged in a specific region. The slit 4 is located near the periphery of the substrate 1. The slit 4 have two arms, which extend along the two straight sides of the rectangular region in which the openings 3 are arranged. As the exposing light, any light used popularly for this purpose may be used. For example, g-line (wavelength: 436 nm), i-line (wavelength: 365 nm), or excimer laser light (KrF, wavelength: 248 nm; ArF, wavelength: 193 nm; F.sub.2, wavelength: 157 nm) may be used. Alternately, electron beam or X ray may be used according to the material of the resist layer 2. As the developer solution, popular tetramethylammonium hydroxide (TMAH) may be used. The

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patterned resist layer 2 with the original openings 3 and the slit 4 is termed the "original resist pattern 20". Subsequent to the optical exposing process described above, the substrate 1 with the original resist pattern 20 is subjected to a heat treatment process at a specific temperature, causing a reflowing action of the resist layer 2 on the substrate 1. The reflowing temperature is set at a temperature equal to or higher than the softening temperature of the resist material of the layer 2. In the reflowing process, the softened resist material reflows along the directions indicated by arrows shown in FIG. 4. In other words, the resist layer 2 causes plastic deformation in such a way that the individual original opening 3 are narrowed or contracted. At this time, the relatively larger flowing action of the resist material in the vicinity of the edges 1a and 1b of the substrate 1 is inhibited by the slit 4. Thus, the reflowing action of the resist material in the neighborhood of the outermost openings 3 located near the edges 1a and 1b is effectively suppressed at approximately the same level as that in the inner area of the substrate 1. Moreover, as described above, the per-opening volumes of the resist material contributing the reflowing action or effect is approximately uniformized or equalized in each opening 3. Thus, the reflowing action or effect of the resist material around each opening 3 is approximately uniform. Since the reflowing action or effect of the resist material around the individual original openings 3 is approximately uniformized, the fluctuation of deformation of the resultant openings 3a is suppressed. This means that the diameter of the resultant openings 3a is substantially uniform independent of the positional difference of the openings 3a on the resist layer 2.

Saito teaches that the resist is developed by conventional methods, but fails to specifically teach developing in the presence of a super critical fluid.

Allen et al disclose a process for generating a negative tone resist image comprising the steps of (1) coating a substrate with a film of a polymeric composition comprising (i) a polymer, (ii) a photosensitive acid generator, and (iii) acid labile groups; (2) imagewise exposing the film to radiation to generate free acid; and (3) developing the image with critical fluid. In one embodiment of the present invention, the polymer comprises acid labile groups pendant from the polymer backbone. The polymer is soluble in critical fluid. In one embodiment, upon imagewise exposure to radiation, the photogenerated acid converts the acid labile group to insoluble polar functionality, thereby enabling negative image development of the film with the critical fluid. In another embodiment, the photogenerated acid cleaves the acid labile, solubilizing (in critical fluid) group. The cleaved groups are then removed (e.g., thermally) from the polymer film, rendering the exposed portions of the film insoluble. The first step of the process involves coating the substrate with a film comprising the polymer, a photosensitive acid generator, and acid labile groups all dissolved in a suitable solvent. The resist film can be either a single layer or bilayer. Suitable substrates are comprised of silicon, ceramics, polymer, or the like. Suitable organic casting solvents include methyl cellosolve acetate, cyclohexanone, propylene glycol monomethyl ether acetate (PGMEA), and the like. Surprisingly, the compositions of the present invention comprising androstane with fluorinated protected hydroxy substituents have enhanced solubility in PGMEA, which is a standard solvent in the industry. Optionally, the film can contain additives such as plasticizers to lower the T_g of the polymer, and also polymers and small molecules to adjust the film's dissolution rate, etch resistance, optical density, radiation sensitivity, adhesion, and the like. The film can be coated on the substrate using art-known techniques such as spin or spray coating, doctor blading, or electrodeposition. Preferably, before

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the film has been exposed to radiation, the film is heated to an elevated temperature of about 90-150 degrees C for a short period of time of about 1 minute. The dried film suitably has a thickness of about 0.5-5.0 microns, preferably about 0.6-1.2 microns. In the second step of the process, the film is imagewise exposed to radiation, suitably electromagnetic, preferably electromagnetic radiation such as deep ultraviolet or X-ray, more preferably deep ultraviolet radiation suitably at a wavelength of about 190-250 nm (248/254 nm), preferably 193 nm. Suitable radiation sources include mercury, mercury/xenon, xenon lamps, and X-ray. The preferred radiation source is ArF excimer or KrF excimer. Conveniently, due to the enhanced radiation sensitivity of the film, a film (0.75 micron thickness) is fully exposed with less than about 10-50 mJ/cm² of radiation, preferably less than about 20-40 mJ/cm², more preferably less than about 30 mJ/cm². The radiation is absorbed by the radiation-sensitive acid generator to generate free acid which converts the acid labile group to insoluble polar functionality. After the film has been exposed to radiation, it is preferably heated to an elevated temperature, preferably at least about 80 to about 150 degrees C for 0.5 to 5 minutes, more preferably about 120 degrees C for 1 minute. The elevated temperature functions to enhance the acid catalyzed cleavage of the acid labile pendant group. The last step of the process of the present invention involves development of the image in the film with critical fluid. A critical fluid, as used herein, is one or more substances heated to a temperature near or above its critical temperature T_c and compressed to a pressure near or above its critical pressure P_c to achieve miscibility with no phase separation. As used herein, a temperature near or above the T_c will be a temperature greater than about 15 degrees C below the T_c. As used herein, a pressure near or above P_c will be a pressure greater than about 10 atmosphere below the P_c. Preferably, the critical fluid is at or

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above the T_c and at or above the P_c . For a critical fluid comprising one substance, there is miscibility between the liquid and gas phase of such a substance. For critical fluids comprising two or more substances, there is miscibility between the two liquids and the two gases of such substances. Suitable substances for use with the process of the present invention include carbon dioxide, ammonia, difluorodichloromethane, methane, ethane, and propane. Other suitable substances will be known to those skilled in the art. To develop the film, the film is placed in a pressure vessel and critical fluid is passed through the vessel over the film. The fluid selectively dissolves the soluble unexposed portion of the film to give a negative tone image. The process enables the development of the film without contamination of the resist with organic developers. The critical fluid is then recycled by flowing out of the vessel through a pressure-reduction valve to drop the pressure and temperature of the fluid (e.g., to ambient), thereby resulting in reduced solubility and precipitation of the dissolved film material from the fluid. The spent critical fluid in the form of liquid/gas is then recycled by reheating and compressing the fluid. The present invention also relates to an integrated circuit made by the process of the present invention such as a circuit chip, circuit board, or semiconductor device comprising a circuit formed on a substrate made by the steps of the process of the present invention. After the substrate has been exposed by the development process of the present invention, circuits can be formed on the exposed areas of the substrate by coating the substrate with a conductive material such as conductive metals by art-known techniques such as evaporation, sputtering, chemical vapor deposition, or laser-induced deposition. Dielectric materials may also be deposited by similar means during the process of making circuits. Inorganic ions such as boron, phosphorous, or arsenic can be implanted in the substrate in the process for making p or n doped circuit

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transistors. Other means for forming circuits will be known by those skilled in the art. The reference teaches the use of developing in the presence of a super critical fluid, but fails to specially teach the method of doing so.

DeSimone et al disclose a process of developing with a super critical fluid, including the specifics and the apparatus to do so. The carbon dioxide liquid may contain a surface tension modifier (e.g., a surfactant) to increase or decrease the surface tension by an amount up to about plus or minus 5 dynes per centimeter. Surface tension modifiers may be included to increase or decrease droplet formation at the boundary of the carbon dioxide liquid coating formed on the substrate during spinning thereof. Surfactants used as such surface tension modifiers should include a CO₂-philic. In operation, a carbon dioxide liquid is applied to the top surface portion of the substrate 12 from the dispenser 17, and the substrate is rotated about an axis (which axis may or may not pass through the substrate) to distribute the carbon dioxide liquid on the top surface portion of the substrate. If desired, the liquid may be dispensed on the substrate and allowed to sit, or remain stationary thereon, for a period of time before spinning is initiated. Either or (preferably) both of the applying step and the rotating step are carried out with the pressure in the chamber greater than atmospheric pressure: in general, with the pressure in the chamber being elevated by at least 10 or 20 pounds per square inch (psi) up to 5,000 or 10,000 psi. The temperature in the chamber is typically maintained at from -53 or -20.degree. C. up to about 20 or 30.degree. C. In addition, as discussed in greater detail below, either (or both) of the applying and spinning steps are carried out (in whole or in part) in an atmosphere comprising carbon dioxide (and other ingredients such as inert gases) while maintaining a differential partial pressure of carbon dioxide between the carbon dioxide liquid applied to the surface portion of

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the substrate and that atmosphere particularly the atmosphere immediately above the top surface portion of the substrate) of between about 10, 20 or 40 mm Hg to about 100, 200 or 400 mm Hg. It may be desired to maintain an essentially constant atmosphere within the chamber as carbon dioxide liquid is applied during one (or more) application and spinning steps. In this case, an atmosphere of carbon dioxide and one or more additional gasses or inert gasses (e.g., helium, nitrogen, argon, oxygen) can be passed into the chamber via line 41 above and vented from the chamber via line 54 above in a controlled manner, so that the composition of the atmosphere within the chamber remains consistent as material is added to the chamber via dispenser 17. The carbon dioxide liquid, when used to remove previously applied materials from the substrate, may consist essentially of carbon dioxide, with minor ingredients such as one or more cosolvents (e.g., tetrahydrofuran, cyclohexane, alcohols such as methanol or ethanol, etc.). When used as a carrier for a compound to be distributed and deposited on the top surface portion of the substrate, the carbon dioxide liquid is a mixture that contains carbon dioxide, optionally one or more cosolvents, and one or more compounds to be carried. Exemplary compounds that may be carried by the carbon dioxide liquid include, but are not limited to, polymers (including polymer precursors or monomers that polymerize or are polymerized after deposition), resists (e.g., photoresists, electron resists, x-ray resists), adhesion promoters, antireflective coatings, and sol-gel precursors. Resists such as photoresists may also contain additives to improve lithographic performance including dissolution inhibitors, photo acid generators, and the like. The photo acid generators are present to allow for chemically amplified resist technology. The mixture may be in any physical form, including solutions, dispersions, and emulsions, but preferably the mixture is a solution. In a preferred embodiment, the mixture is comprised of carbon dioxide and a

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fluoropolymer, and more preferably a fluoroacrylate polymer. Examples of such mixtures are disclosed as the polymerization product described in U.S. Pat. No. 5,496,901 to DeSimone, the disclosure of which is incorporated herein by reference. In a preferred embodiment, such mixtures are applied to the top surface portion of a semiconductor (e.g., silicon) substrate to serve as a photoresist. The carbon dioxide liquid may contain a viscosity modifier such as an associative polymer to increase the viscosity thereof and alter the thickness of the surface coating. The viscosity modifier may, for example, be included in an amount sufficient to increase the viscosity of the carbon dioxide group and a CO₂-phobic group and are known in the art. If desired, the carbon dioxide liquid may contain a co-solvent that evaporates more slowly than does carbon dioxide (e.g., alcohols, ketones such as cyclopentanone, butyl acetate, xylene). Substrates coated with such a carbon dioxide liquid may then be removed from the pressure vessel and dried. Such a technique may be employed to reduce pin holes in the coating formed on the substrate.

Given the teachings of the references, it would have been obvious to one of ordinary skill in the art to prepare the material of Saito employing the developer and development method of Allen et al in view of DeSimone with reasonable expectation of achieving a resist pattern having via holes.

5. Claims 1-3, 7-12, 14, 16-18, and 22-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Saito (6,589,718) in view of Gerlach, Jr. et al (3,658,543).

Saito et al has been discussed above. The reference teaches that any conventional additives may be added to the resist, but fails to specifically teach the addition of a plasticizer.

Gerlach, Jr. et al disclose photosensitive compositions which are activated toward color generation by radiation of wavelength λ_1 and are rapidly and permanently deactivated toward color generation by radiation of wavelength λ_2 . The improved compositions comprise a color-forming system of (a) an acid salt of an oxidizable, substituted, leuco aminotriarylmethane, and (b) a hexaarylbiimidazole which absorbs principally in the ultraviolet region and is a photooxidant for the leuco aminotriarylmethane and a deactivating system of (1) a polynuclear quinone absorbing principally in the 400-550 nm. region and (2) 0 to 90 percent of a lower alkyl ester of nitrilotriacetic or nitrilotripropionic acid and 10 to 100 percent of a short-chained acyl ester of triethanolamine. With some polymers, it is desirable to add a plasticizer to give flexibility to the film or coating. Plasticizers include the polyethylene glycols such as the commercially available carbowaxes, and related materials, such as substituted phenoethylene oxide adducts, for example the polyethers obtained from o-, m- and p-cresol, o-, m- and p-phenylphenol and p-nonylphenol, including commercially available materials such as the "Igepal" alkyl phenoxy polyoxyethylene ethanols. Other plasticizers are the acetates, propionates, butyrates and other carboxylate esters of ethylene glycol, diethylene glycol, glycerol, pentaerythritol and other polyhydric alcohols, and alkyl phthalates and phosphates such as dimethyl phthalate, diethyl phthalate, dioctyl phthalate, tributyl phosphate, trihexyl phosphate, trioctyl phosphate, triphenyl phosphate, tricresyl phosphate and cresyl diphenyl phosphate. These plasticizers can be used in concentrations ranging from 1:20 to 5:3 and preferably 1:5 to 1:2, based on the weight of the binder used. Particularly useful plasticizers, frequently employed in conjunction with the above polymers, are alkyl arenesulfonamides of the structure.

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Given the teachings of the references, it would have been obvious to one of ordinary skill in the art to prepare the material of Saito choosing to add the plasticizer for the advantages taught by Gerlach, Jr. et al with reasonable expectation of achieving a resist pattern having via holes.

6. Claims 5, 6, 20, and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hallock et al (6,582,891 or 6,709,807) in view of Allen et al (5,665,527) and DeSimone et al (6,383,289).

All four references have been discussed above. Hallock et al discloses that the photoresist may be patterned using conventional lithography and developers (example 1, column 12 (for the '891 reference)).

Given the teachings of the references, it would have been obvious to one of ordinary skill in the art to prepare the material of Hallock et al choosing to employ the developer of Allen et al in view of DeSimone et al with reasonable expectation of achieving a pattern having reduced line edge roughness.

Conclusion

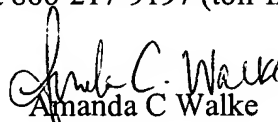
7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Mautz (6,420,098), Chiang et al (6,365,325), Nam (6,803,308), Field et al (4,546,066), Feng (4,022,932), Kido (6,756,187), Kye (6,602,794), Arao (6,432,620), Numakura (5,286,609), Ho et al (6,645,851), Bantu et al (6,127,097), Nishikawa et al (4,944,837), Arita (US 2004/0038549) are cited for their teachings of similar methods and materials.

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Any inquiry concerning this communication or earlier communications from the examiner should be directed to Amanda C Walke whose telephone number is 571-272-1337. The examiner can normally be reached on M-R 5:30-4.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Cynthia Kelly can be reached on 571-272-1526. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).


Amanda C Walke
Examiner
Art Unit 1752

ACW
March 15, 2005